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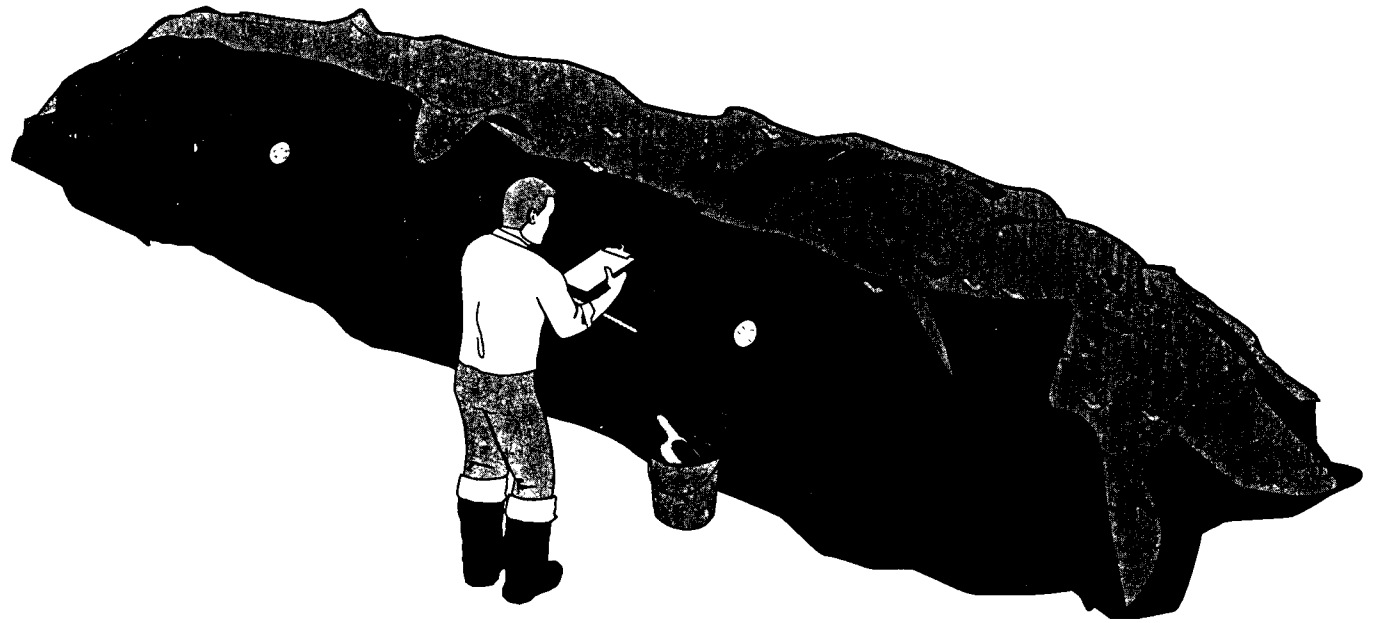
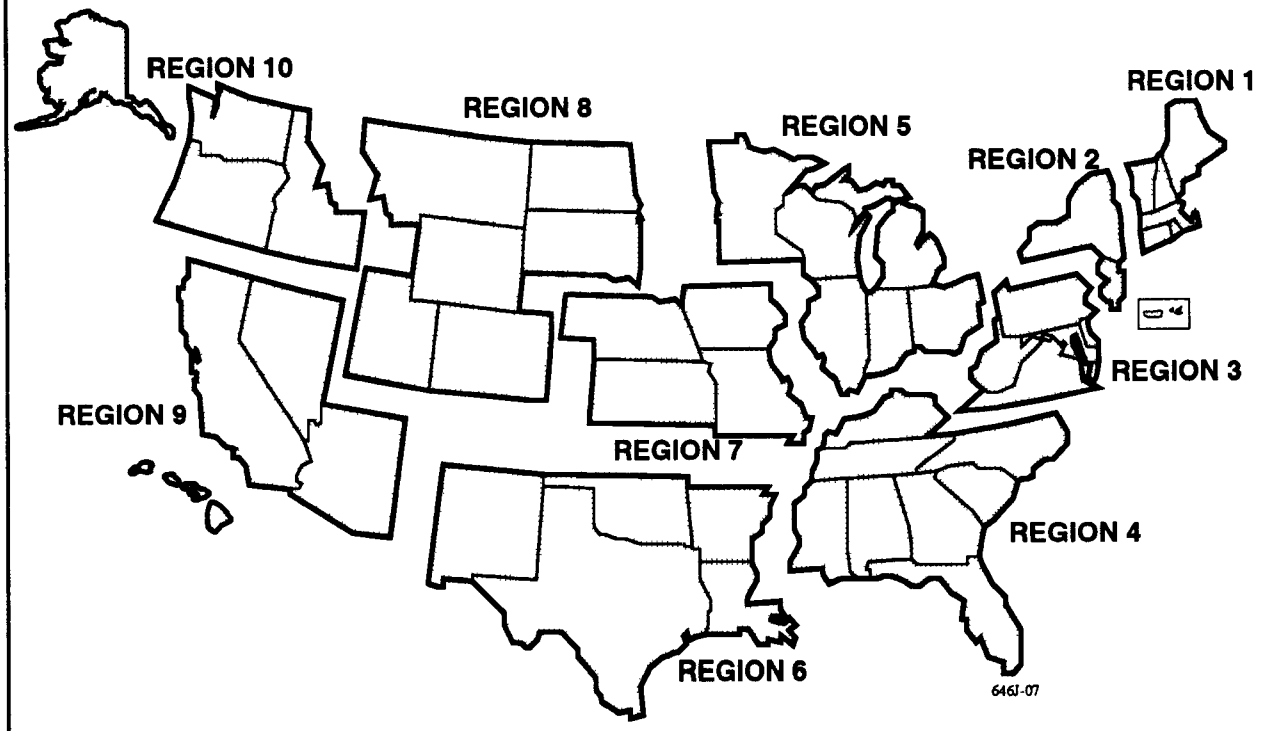
Preparing Sewage Sludge For Land Application Or Surface Disposal

A Guide for Preparers of Sewage Sludge on the Monitoring, Record Keeping, and Reporting Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge, 40 CFR Part 503



General questions concerning the Standards for the Use and Disposal of Sewage Sludge should be directed to the EPA Regional Sludge Coordinator. The Sludge Coordinators can be reached by calling the following numbers:

• **Region 1**	Boston, MA	(617) 565-3560
• **Region 2**	New York, NY	(212) 264-5677
• **Region 3**	Philadelphia, PA	(215) 597-9078
• **Region 4**	Atlanta, GA	(404) 347-2391
• **Region 5**	Chicago, IL	(312) 353-2106
• **Region 6**	Dallas, TX	(214) 655-7520
• **Region 7**	Kansas City, KS	(913) 551-7443
• **Region 8**	Denver, CO	(303) 293-1627
• **Region 9**	San Francisco, CA	(415) 744-1910
• **Region 10**	Seattle, WA	(206) 553-1728



Mail compliance reports required under the Standards for the Use and Disposal of Sewage Sludge to the Water Compliance Branch Chief in your EPA Region at the address listed on the back cover.

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1. INTRODUCTION

Under the authority of Section 405(d) of the Clean Water Act as amended, the U.S. Environmental Protection Agency (EPA) has promulgated, at 40 Code of Federal Regulations (CFR) Part 503, Phase I of the risk-based regulations that govern the final use or disposal of sewage sludge. The intent of this Federal program is to ensure that the use or disposal of sewage sludge occurs in a way that protects both human health and the environment. The Part 503 regulation establishes general requirements, pollutant limits, operational standards, and management practices, as well as monitoring, recordkeeping, and reporting requirements. These requirements apply to sewage sludge that is land applied, placed on a surface disposal site, or incinerated in a sewage sludge only incinerator. The following types of sludge are not subject to Part 503 but are regulated under other Federal rules:

- Sludge generated from the treatment of industrial process waste at an industrial facility (40 CFR Part 257 if non-hazardous)
- Hazardous sewage sludge (40 CFR Parts 264, 265, 267 and 268)
- Sewage sludge with a polychlorinated biphenyls (PCB) concentration of 50 ppm or greater (40 CFR Part 761)
- Drinking water treatment sludge (40 CFR Part 257).

Part 503 imposes requirements on four groups:

- Persons who prepare sewage sludge or material derived from sewage sludge
- Land appliers of sewage sludge
- Owners/operators of sewage sludge surface disposal sites
- Owners/operators of sewage sludge incinerators.

The regulation is largely self-implementing. This means that anyone engaged in activities covered by this regulation must comply with the appropriate requirements on or before the compliance deadlines (see Table 1). A person who violates Part 503 is subject to administrative, civil, and/or criminal enforcement actions.

EPA recognizes that implementation of Part 503 requirements may be a source of confusion for those who already have a State or local permit with sewage sludge requirements because these people now have

Table 1
Compliance Deadlines for 40 CFR Part 503

Requirement	Compliance Deadline
Monitoring, recordkeeping, and reporting requirements	July 20, 1993
All other requirements (i.e., general requirements, pollutant limits, pathogen reduction, vector attraction reduction, and management practices)	February 19, 1994*

*If compliance requires construction of new pollution control facilities, the compliance deadline is extended to February 19, 1995. A new pollution control facility is any building, structure, facility, or installation from which there is or may be a discharge of pollutants, the construction of which began after the promulgation of Part 503, and includes any building, structure, facility, or installation that replaces or substantially upgrades the process or production equipment necessary to meet a standard under this Part. The definition of new pollution control facility does not include: (1) replacement of any building, structure, facility, or installation due to normal operational wear and tear; and (2) installation of monitoring equipment or devices, including the purchase of computer hardware or software for monitoring purposes.

to comply with two sets of requirements—those in their permit and those in Part 503. To reduce some of this confusion, EPA developed a series of guidance documents to explain the requirements of Part 503. A list of these documents is provided in the references section at the end of this document.

This particular document focuses on the monitoring, recordkeeping, and reporting requirements that apply to persons who prepare sewage sludge or a material derived from sewage sludge. The remainder of this introduction defines persons who prepare sewage sludge and then summarizes their general responsibilities. The introduction is followed by three sections that detail the monitoring, recordkeeping, and notification and reporting requirements, respectively.

Separate documents explaining the monitoring, record keeping, and reporting responsibilities of land appliers and owners/operators of surface disposal sites are also available. The following documents may be obtained through the EPA regional offices listed on the back cover of this document:

- *Land Application of Sewage Sludge — A Guide for Land Appliers on the Recordkeeping and Reporting Requirements of the Federal Standards for the Use and Disposal of Sewage Sludge Management in 40 CFR Part 503* (EPA, 1993)
- *Surface Disposal of Sewage Sludge — A Guide for Owners/Operators of Surface Disposal Facilities on the Monitoring, Recordkeeping, and Reporting Requirements of the Federal Standards for the Use and Disposal of Sewage Sludge in 40 CFR Part 503* (EPA, 1993).

1.1 Definition of Person Who Prepares Sewage Sludge

The regulation defines the person who prepares sewage sludge as "either the person who generates sewage sludge during the treatment of domestic sewage in a treatment works or the person who derives a material from sewage sludge." This definition covers two types of operations—those that generate sewage sludge and those that take sewage sludge after it has been generated and blend or mix it with another material to further process or prepare it before its ultimate use or disposal. Operations that generate sewage sludge include publicly owned treatment works, privately owned treatment works, and federally owned treatment works that treat, recycle, or reclaim either domestic sewage or a combination of domestic sewage and industrial waste. Operations that derive a material from sewage sludge include composting facilities and fertilizer blending facilities that change the initial quality of the sewage sludge and create a product for use as a soil amendment or fertilizer. Any time the sludge quality (pollutant concentrations, pathogen levels, or vector attraction characteristics) is changed, the person responsible for the change is defined as a person who prepares sewage sludge. For example, any sludge management facility, such as regional composting operation, that mixes or blends sewage sludge received from other facilities is a preparer.

Sewage Sludge—Solid, semi-solid, or liquid residue generated during the treatment of domestic sewage in a treatment works. Sewage sludge includes but is not limited to:

- Domestic septage (including septage from portable toilets)
- Scum or solids removed in primary, secondary, or advanced wastewater treatment processes
- A material derived from sewage sludge.

Sewage sludge does not include:

- Ash generated in a sewage sludge incinerator
- Grit and screenings generated during preliminary treatment of domestic sewage in a treatment works.

1.2 Responsibilities of Preparers of Sewage Sludge

The person who prepares the sewage sludge is responsible for documenting sludge quality. The quality of the sludge affects the final use or disposal practices available. As illustrated in Figure 1, the sludge quality requirements differ within a use or disposal practice. For example, under surface disposal, the sludge quality limits are affected by whether or not the active sewage sludge unit has a liner and leachate

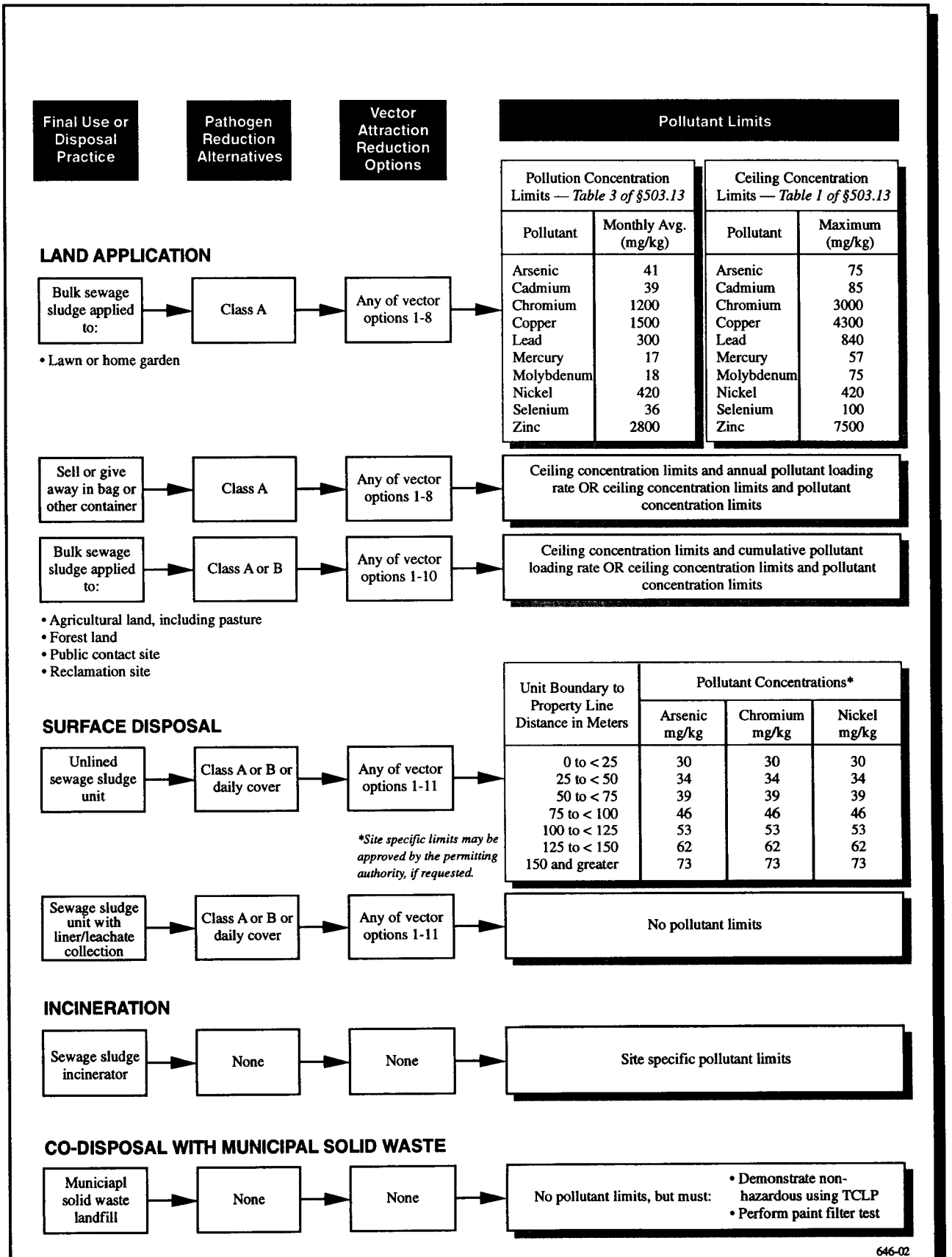

Figure 1: Sludge Quality Requirements for Use or Disposal Practices

collection system. The preparer must know what the final use or disposal practice will be and document that the sludge quality meets the appropriate requirements.

EPA anticipates that most preparers generating sewage sludge are able to control the type and amount of pollutants that ultimately end up in the sludge through implementation of local mechanisms, such as pretreatment programs. Therefore, the Part 503 regulation requires the preparer to evaluate sludge quality, maintain records, submit compliance reports, and distribute sludge quality information to subsequent users who need the information to comply with the other requirements of the sewage sludge regulation. Subsequent users may include:

- Sludge processors, such as fertilizer blenders, composting operations, and pelletization facilities, that further prepare the sludge and either land apply it themselves or distribute it for land application
- Land appliers
- Owners or operators of surface disposal facilities
- Owners or operators of sewage sludge incinerators.

These subsequent users will usually rely on the preparer to provide them with the sludge quality information necessary to comply with the requirements of the regulation. However, there are several circumstances where the subsequent users will perform sludge monitoring in addition to or instead of the initial preparer. Sometimes the preparer generating the sewage sludge transfers it to a processing facility where it is prepared for land application. It is possible that the preparer generating the sludge and the preparer processing the sludge may enter into an agreement stipulating that the preparer processing the sewage sludge will be responsible for some or all of the monitoring requirements instead of the preparer generating the sludge. When sewage sludge is placed on an active surface disposal unit fewer than 150 meters from the site property line, then the owner/operator of the site is responsible for monitoring sludge quality instead of the preparer. Finally, regional incinerator that accepts sludge from numerous preparers may choose to monitor the combined sludge fed into the incinerator to verify that the mixture meets the sludge quality limits.

If a subsequent user derives a material from the sewage sludge, then that user is a preparer by definition, as described in the previous section. The subsequent user/preparer who changes the quality of the sludge is required to independently evaluate the final sewage sludge product and keep records documenting sludge quality. However, if the original sewage sludge meets the criteria for exceptional quality sewage

sludge (see box given below), then additional monitoring is not required as long as records document the receipt of exceptional quality sewage sludge.

Exceptional Quality Sewage Sludge—Sewage sludge or material derived from sewage sludge is classified as exceptional quality if it meets the following criteria:

- Requirements concerning pollutant concentrations [40 CFR 503.13(b)(3)]
- One of the Class A pathogen reduction alternatives [40 CFR 503.32(a)]
- One of the vector attraction reduction options accomplished during sludge treatment (Options 1-8) [40 CFR 503.33(b)(1)-(8)].

2. MONITORING

Monitoring sewage sludge quality is a key step to ensuring compliance with the Part 503 requirements. Most preparers must establish a self-monitoring program to document that sludge quality levels are met consistently. The following materials contain detailed guidance on the collection and analysis of sewage sludge samples:

- *POTW Sludge Sampling and Analysis Guidance Document* (EPA, 1989 and updates)
- *Standard Methods for the Examination of Water and Wastewater*, 18th edition (APHA, 1992)
- *Test Methods for Evaluating Solid Waste Physical/Chemical Methods*, EPA Publication SW-846 (EPA, 1986)
- *Environmental Regulations and Technology: Control of Pathogens and Vectors in Sewage Sludge*, EPA/625/R-92/013 (EPA, 1992)
- *Sewage Sludge Sampling Techniques*. Demonstration Video (EPA, 1993).

2.1 Regulated Parameters (or what to monitor)

Regulated parameters include inorganic pollutants (i.e., metals), pathogenic and non-pathogenic indicator organisms, and vector attraction characteristics. The specific parameters to monitor vary depending on whether the sludge is land applied, incinerated, or placed on a surface disposal site. The parameters also vary depending on which pathogen reduction alternative or vector attraction reduction option is used.

Sludge that is land applied or placed on an unlined surface disposal site must be monitored for inorganic pollutants. The sludge must also be monitored for pathogens, indicator organisms, and vector attraction characteristics when called for by the pathogen reduction alternative or vector attraction reduction option. Sludge does not have to meet pollutant limits when it is placed on a surface disposal site that is equipped with a liner and leachate collection system, but it must meet pathogen and vector attraction reduction requirements. Note that sludge placed on a surface disposal site does not have to meet pathogen reduction requirements if it is covered with soil or other suitable material after placement. Sludge that is incinerated only has to be analyzed for inorganic pollutants.

Indicator Organism—An indicator organism (e.g., fecal coliform) is a non-pathogenic organism whose presence implies that contamination has occurred. Indicator organisms are selected to be conservative estimates of potential contamination.

Vector Attraction—Characteristics (e.g., odor) that attract birds, insects, and other creatures capable of transmitting infectious agents.

Pollutants

The presence of inorganic pollutants in sludge is the first component of sludge quality. Table 2 lists the inorganic pollutants regulated under 40 Code of Federal Regulations (CFR) Part 503 for land application or surface disposal (unlined units). At a minimum, sludge must be monitored for these pollutants. The preparer may have to monitor the sewage sludge for additional pollutants if specified in a permit or required by the person(s) responsible for the ultimate use or disposal of the sludge. When bulk sewage is going to be land applied, nitrogen analysis must also be conducted.

Table 2
Pollutants Monitored for Land Application and Surface Disposal

Pollutant	Land Application	Surface Disposal (unlined units)
Arsenic	✓	✓
Cadmium	✓	
Chromium	✓	✓
Copper	✓	
Lead	✓	
Mercury	✓	
Molybdenum	✓	
Nickel	✓	✓
Selenium	✓	
Zinc	✓	

The pollutant limits are expressed as dry weight concentrations. Therefore, in addition to the pollutants, the percent solids content of the sludge must be determined to verify compliance with pollutant limits.

The percent solids value is used to convert pollutant concentrations to a dry weight basis, as demonstrated in Figure 2.

If you assume that the specific gravity of the solids is equivalent to the specific gravity of water, a simplified equation can be used to express the concentration of a pollutant on a dry weight basis:

$$A \frac{mg}{L} \div Percent\ Solids = B \frac{mg}{kg}$$

where: A is the concentration of the pollutant in the sewage sludge on a wet basis in mg/L and B is the concentration of the pollutant in the sewage sludge on a dry weight basis in mg/kg.

For example, assume that the concentration of zinc in the sewage sludge is reported as 200 mg/L and the percent solids content of the sewage sludge is 24 percent. The concentration can be converted to a dry weight basis using the equation given above:

$$200 \frac{mg}{L} \div 0.24 = 8334 \frac{mg}{kg}$$

Figure 2: Expressing Pollutant Concentrations on a Dry Weight Basis

Pathogenic Organisms

The presence of pathogenic organisms, such as bacteria and viruses, is another component of sludge quality. When sludge is prepared for land application or surface disposal, it must comply with applicable pathogen reduction requirements. There are no pathogen reduction requirements for sewage sludge that is incinerated.

The Part 503 regulation allows nine pathogen reduction alternatives, which are divided into two distinct classes: Class A and Class B. Class A alternatives produce a sludge that is virtually pathogen free (see Table 3 for allowable levels). Class B alternatives, while not as effective as Class A, significantly reduce the pathogen level in sludge. Both Class A and B alternatives specify maximum levels of fecal coliform, Salmonella sp. bacteria, enteric viruses, and/or helminth ova allowed in the sludge. Most alternatives also specify operating parameters that must be consistently achieved during sludge treatment. The operating parameters are described in Section 3.2 (Records of Pathogen Reduction) because records must be kept to demonstrate that the operating parameters were met on a regular basis. The remainder of this

section addresses monitoring for the presence of fecal coliform, Salmonella sp. bacteria, enteric viruses, and viable helminth ova.

Table 3
Indicator Organisms and Pathogens Monitored Under
40 CFR Part 503

Pathogen Reduction Alternatives	Organism to be Monitored	Allowable Level in Sludge
All Class A Alternatives 1, 2, 3, 4, 5, 6	Fecal Coliform	1,000 Most Probable Number (MPN) per gram (Class A) of total solids (dry weight)
All Class A Alternatives 1, 2, 3, 4, 5, 6	Salmonella sp. bacteria (in lieu of fecal coliform)	3 MPN per 4 grams total solids (dry weight)
Class A Alternatives 3 and 4 only	Enteric Viruses	Less than one plaque-forming unit per 4 grams total solids (dry weight)
Class A Alternatives 3 and 4 only	Viable Helminth Ova	Less than one viable helminth ovum per 4 grams of total solids (dry weight)
Class B Alternative 1	Fecal Coliform	Less than 2 x 10^6 MPN or less than 2 x 10^6 colony-forming units per gram of total solids (dry weight) (expressed as geometric mean of the results of 7 individual samples)

All of the Class A and one of the Class B pathogen reduction alternatives require monitoring to demonstrate that the density of pathogens or indicator organisms in the sewage sludge is below specified values. Depending on which pathogen reduction alternative is used, the preparer may need to monitor for one or more of the following organisms: fecal coliform, Salmonella sp. bacteria, enteric viruses, and viable helminth ova. Table 3 describes which organisms must be monitored for each alternative requiring analysis. Note that allowable pathogen levels also are expressed as dry weight.

Vector Attraction Characteristics

Vector attraction characteristics are the third basic component of sludge quality. Vectors are animals and insects (e.g., rodents, flies, birds) that could potentially transmit pathogenic organisms from the sewage sludge to humans. Vectors may be attracted to sludge by its odor and putrescibility. Therefore, these characteristics must be reduced by using any of the 11 options given in the regulations.

The types of parameters used to demonstrate vector attraction reduction include volatile solids reduction, specific oxygen uptake rate, and percent total solids. Most of the vector attraction reduction alternatives also involve the documentation of operating parameters and evaluation of sludge management activities to demonstrate compliance. Facilities are required to maintain records describing the methods used and certifying that requirements for vector attraction reduction have been met. Section 3.3 describes the specific types of records that must be kept to demonstrate compliance.

2.2 Monitoring Frequency (or when to monitor)

The Part 503 regulations establish a monitoring frequency for sewage sludge and materials derived from sewage sludge. As shown in Table 4, the monitoring frequency increases as the amount of sludge used or disposed increases. The monitoring frequency established by the regulation does not restrict preparers from analyzing sludge quality more often. In fact, more frequent sampling and analysis may be advantageous. The results of each sampling event represent the sludge quality from the date the sample was taken until the date of the next sample. If a preparer samples quarterly and the results show that the sludge quality exceeded a limit, then all the sludge used or disposed after that sample was collected will be in violation until another sample is collected and analyzed to show that the sludge is in compliance. Thus, preparers who collect samples of sludge more frequently may be able to document that in general the sludge quality consistently meets applicable requirements and that exceedances, if any, are abnormal events.

Table 4
Monitoring Frequency

Amount of Sewage Sludge Used or Disposed (metric tons per 365-day period; dry weight)	Monitoring Frequency Per Year
Greater than zero but less than 290	Once
Equal to or greater than 290 but less than 1,500	Quarterly (4 times)
Equal to or greater than 1,500 but less than 15,000	Bimonthly (6 times)
Equal to or greater than 15,000	Monthly (12 times)

Technically, sludge does not exceed use or disposal requirements until it is used or disposed. A preparer can prevent a violation from occurring by waiting for the analytical results before releasing the sludge for use or disposal. The concentrations of the regulated parameters (i.e., pollutants and pathogens)

remain fairly constant once the sludge has been prepared for final use or disposal, with the exception of fecal coliform and Salmonella sp. bacteria. Therefore, after a reasonable waiting period (of 3-7 weeks), the analytical results of the sludge sampled should still reflect the quality of the sludge used or disposed.

Obviously, a preparer's ability to use this strategy will depend on the availability of space to store the sewage sludge in a manner that will protect it from contamination. Where storage is not a feasible alternative, preparers will have to be more conservative in how they use or dispose of the sludge until they have generated enough historical monitoring data to demonstrate that the sludge consistently meets sludge quality requirements. Until preparers are confident they can consistently achieve Class A, they may want to manage sludge as if it is Class B.

The Part 503 regulation specifies the number of sampling events that must occur during a year. The interval between sampling events is also defined. For example, the monitoring frequency "once per quarter (4 times per year)" means a total of four sampling events must occur at 3-month intervals (i.e., one sampling event every 3 months). The four sampling events cannot occur in 4 consecutive days (or weeks or months) if the preparer is continuously using or disposing of sludge for 365 days. There may be individual situations where the interval stipulated by the regulation (e.g., once every 60 days) can be modified.

For example, sewage sludge may be prepared at a faster rate than the preparer uses or disposes of the sludge. It is possible for a facility to prepare, over a 12-month period, an amount of sewage sludge that requires bimonthly sampling and analysis (e.g., 3,000 dry metric tons). The facility may, however, only land apply the sludge during a 3-month period because of the local growing season. In this situation, the preparer may sample and analyze the sewage sludge on a bimonthly (every 2 months) basis for all applicable parameters that remain fairly constant in the sludge after it has been processed and prepared for final use or disposal (i.e., metals, enteric viruses, viable helminth ova). However, because fecal coliform and Salmonella are prone to regrowth, analysis for these parameters must be performed during the 3-month period that the sewage sludge is land applied. The preparer should perform biweekly (every 2 weeks) monitoring during that period to comply with the monitoring frequency (six times per year) and the timing restriction (at the time of use or disposal).

For most treatment works treating domestic sewage, monitoring events should be performed at regular intervals throughout the year as the sludge is being prepared rather than after it has been stockpiled or otherwise stored. Regular monitoring gives the preparer timely feedback on changes in sludge quality,

thereby allowing the preparer to identify and correct problems early. However, if the sludge quality is likely to change between the time it is prepared and the time it is used or disposed, then the monitoring events should be scheduled so that the data are representative of the sludge that is ultimately used or disposed. For example, if a sludge with a high liquid content is stored in a tank or lagoon, it is likely to produce a leachate or supernatant that will be drawn off the sludge solids as they settle. This could result in increased concentrations of pollutants in the sludge since the metals bind more readily to the solids than the liquid fraction of the sludge. The monitoring events should be scheduled to collect representative samples of the sludge used or disposed at a frequency appropriate for the amount of sludge used or disposed during the calendar year.

Another situation requiring possible modification of the monitoring interval is when the preparer has been stockpiling sludge for an extended period of time and, now that the regulations are in effect, needs to start sampling as the sludge is used or disposed. In this case, the preparer should determine how much sludge will be used or disposed in a 365-day period and calculate the corresponding monitoring frequency. The preparer should schedule sampling events at evenly spaced intervals during the time when sludge is used or disposed.

2.3 Procedures for Sampling and Analysis (or how to monitor)

This section describes three critical factors in the development and implementation of a self-monitoring program that will produce precise and reliable analytical results:

- Collection of representative samples of the sewage sludge
- Use of appropriate analytical techniques
- Adherence to quality assurance/quality control (QA/QC) procedures for sampling and analysis.

Representative Samples

To obtain a valid sample of sewage sludge, the sample must be taken from the correct location, represent the entire amount of sludge, and be handled properly from the time of collection through analysis. It is important that samples be collected from a location that is representative of the final sewage sludge or sewage sludge product. Therefore, sludge samples must be collected after the last treatment process (e.g., digestion, dewatering, drying, composting). Samples should be taken at the same point and in the same manner each time monitoring is performed. This location should be safe and accessible.

The technique for sampling the sludge will vary depending on whether the sludge is flowing through pipes, moving along a conveyor, or contained in a truck, pile, or bin. Sludge that is flowing or moving should be sampled at equal intervals during the amount of time the unit operates in a day. This technique is desirable because moving sludge is likely to be better mixed than sludge in a pile or bin. If sludge samples must be collected from a pile or bin, the appropriate number of sample aliquots to collect from various points in the pile should be determined using the statistical procedure described in the *POTW Sludge Sampling and Analysis Guidance Document* (EPA, 1989 and updates). At a minimum, full-core samples should be taken from at least four points in the pile or bin. Sludge sampling techniques are described in the following references, which are available through the Regional sludge coordinator:

- *POTW Sludge Sampling and Analysis Guidance Document* (EPA, 1989 and updates)
- *Environmental Regulations and Technology: Control of Pathogens and Vectors in Sewage Sludge*, EPA/1625/R-92/013 (EPA, 1992)
- *Sewage Sludge Sampling Techniques*. Demonstration Video (EPA, 1993).

Appropriate preservation techniques ensure that samples remain representative during the time that are held prior to analysis. At a minimum, all sludge samples in the field and in the laboratory should be preserved by cooling to 4°C. In addition to preservation, the holding time influences the validity of analytical results. It is important to know and respect sample holding times for each parameter being analyzed. With the exception of mercury, the metals do not degrade easily and can be held up to 6 months. Mercury can be held for 13 days in a plastic container and 38 days in a glass container. Bacteria have a very short holding time; if the samples cannot be delivered to the laboratory within 1 hour, they should be chilled promptly (using an ice and water bath) to 4°C and delivered within 24 hours. Samples for viable helminth ova can be held for up to 1 month if chilled to 4°C. Viruses can be frozen for up to 2 weeks.

In addition, appropriate sample containers must be used. For some parameters, such as volatile organics, glass containers are essential. However, either plastic or glass containers can be used to collect samples for the analysis of metals, indicator organisms, and pathogens. The containers must be clean and contaminant free. Sterile containers must be used for indicator organisms and pathogens.

Finally, sufficient sample volumes must be collected to perform the analyses. The sample volumes needed for each analysis vary depending on the percent total solids of the sewage sludge and the detection

level of the analytical method used. Check with your laboratory to make sure you collect more than enough sludge for analysis. A conservative rule of thumb is to collect 500 ml for metals analysis and 1 L for pathogens and indicator organisms.

Appropriate Analytical Techniques

All analyses performed to comply with Part 503 must be conducted using methods specified in Part 503. Pollutant analysis for metals must be performed using the methods provided in *Test Methods for Evaluating Solid Waste (SW-846)* (EPA 1986). Table 5 lists the methods for the analysis of regulated pollutants. Methods for pathogen analysis, specific oxygen uptake rate, and total, fixed, and volatile solids can be found in the following references:

- **Enteric Viruses:** *Standard Practice for Recovery of Viruses From Wastewater Sludge*, Section 11, Water and Environmental Technology (ASTM, 1992).
- **Fecal Coliform:** *Standard Methods for the Examination of Water and Wastewater*, Part 9221 E or Part 9222 D, 18th edition, (APHA, 1992).
- **Helminth Ova:** W.A. Yanko, *Occurrence of Pathogens in Distribution and Marketing Municipal Sludges* (EPA, 1987).
- **Salmonella Sp. Bacteria:** *Standard Methods for the Examination of Water and Wastewater*, Part 9260 D.I., 18th edition, (APHA, 1992); B.A. Kenner and H.A. Clark, Determination and Enumeration of *Salmonella* and *Pseudomonas aeruginosa*, *J. Water Pollution Control Federation*, 46(9): 2163-2171, 1974.
- **Specific Oxygen Uptake Rate:** *Standard Methods for the Examination of Water and Wastewater*, Part 2710 B, 18th edition, (APHA, 1992).
- **Total, Fixed, and Volatile Solids:** *Standard Methods for the Examination of Water and Wastewater*, Part 2540 G, 18th edition, (APHA, 1992).

Quality Assurance/Quality Control

QA programs are used to achieve a desired quality for activities, such as sample collection, laboratory analysis, data validation and reporting, documentation, and recordkeeping. QA programs should address the following major areas:

- Proper sample collection procedures, equipment, preservation methods, and chain-of-custody procedures to ensure representative samples
- Proper sample preparation procedures, instruments, equipment, and methodologies used for the analyses of samples

Table 5
Methods for the Analysis of Metals in Sewage Sludge

Pollutants	Sample Preparation and Analytical Methodologies SW-846*
Arsenic	EPA Methods 3050/3051 + 7061
Cadmium	EPA Methods 3050/3051 + 6010/7131/7130
Chromium	EPA Methods 3050/3051 + 6010/7191/7190
Copper	EPA Methods 3050/3051 + 6010/7210
Lead	EPA Methods 3050/3051 + 6010/7421/7420
Mercury	EPA Method 7471/7470
Molybdenum	EPA Methods 3050/3051 + 6010/7481/7480
Nickel	EPA Methods 3050/3051 + 6010/7520
Selenium	EPA Methods 3050/3051 + 6010/7741/7740
Zinc	EPA Methods 3050/3051 + 6010/7950

**Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, EPA Publication SW-846, Second Edition (1982) with Updates I (April 1984) and II (April 1985) and the Third Edition (November 1986) with Revision I (December 1987) and Update I (July 1992). The Second Edition and Updates I and II (PB-87-120-291) are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. The Third Edition and Revision I and Update I (Document number 955-001-00000-1) are available from the Superintendent of Documents, Government Printing Office, 941 North Capitol Street, NE, Washington, DC, 20002. Future updates will be noticed in the *Federal Register*.

- Proper procedures and schedules for the calibration and maintenance of equipment and instruments associated with the collection and analyses of samples
- Proper recordkeeping to produce accurate and complete records and reports, when required.

QC, which is part of the QA program, relates to the routine use of established procedures and policies during sample collection and analysis. The objective of QC procedures is to ultimately control both the accuracy and the precision of all analytical measurements made. QC for sample collection includes the use of duplicate and spiked samples, as well as sample blanks. QC for sample analysis includes the use of spiked and split samples, proper calibration protocols, and appropriate analytical methods and procedures. Guidance on QA/QC for sample collection and analysis is contained in Chapter 1 of *Test Methods for Analysis of Solid Waste* (SW-846)(EPA, 1986). Each analytical method describes additional QC procedures for the specific method.

3. RECORDKEEPING

Persons who prepare sewage sludge are required to keep records of sludge quality. With respect to pollutants, the Part 503 regulation requires the preparer to maintain records documenting the concentration of pollutants in the sludge. With respect to pathogens and vector attraction, the records must describe how the pathogen and vector attraction reduction requirements were met and include a signed certification of their achievement. The regulations specify that records be maintained for a period of at least 5 years.

This section provides guidance to preparers on the specific records needed to document compliance. The records must be kept so that they are readily accessible to State and EPA inspectors. Preparers should be aware that failure to keep adequate records is a violation of the Part 503 regulations and subject to administrative, civil, and/or criminal penalty under the Clean Water Act.

3.1 Records of Pollutant Concentrations

The preparer is responsible for maintaining the following documentation of sampling and analysis for pollutant concentrations:

- Date and time of sample collection, sampling location, sample type, sample volume, name of sampler, type of sample container, and methods of preservation, including cooling
- Date and time of sample analysis, name of analyst, and analytical methods used
- Laboratory bench sheets indicating all raw data used in the analyses and the calculation of results (unless a contract laboratory performed the analyses for the preparer)
- Name of contract laboratory, if applicable.
- Sampling and analytical quality assurance/quality control(QA/QC) procedures
- Analytical results expressed in dry weight.

When sewage sludge or the material derived from sewage sludge that is going to be land applied does not meet the pollutant concentration limits in Table 3 of 40 CFR Part 503.13 (see Figure 1 on page 4), additional records must be kept to demonstrate compliance with the pollutant limits in 40 CFR 503.13. These records must demonstrate compliance with either the cumulative pollutant loading rate or the annual

pollutant loading rate, as appropriate. If the preparer plans to sell or give away the sewage sludge in a bag or other container, he or she must develop and retain the following additional records:

- Calculation of an annual whole sludge application rate (AWSAR) that will not exceed the annual pollutant loading rate in Table 4 of 40 CFR 503.13 for each regulated pollutant. Appendix A of this document provides a worksheet to assist in calculating the AWSAR. The AWSAR must be distributed with the sewage sludge on a label or information sheet.
- A copy of the label or information sheet provided to persons who will land apply the sludge.

If the preparer is going to land apply bulk sewage sludge, additional records that track the cumulative pollutant loading rate for each land application site must be developed and maintained. The preparer should refer to the guidance document for land appliers for detailed information on additional recordkeeping requirements for land appliers.

3.2 Records of Pathogen Reduction

The Part 503 regulation require the maintenance of records that include a description of how compliance was achieved and a certification that the pathogen requirements were met. In general, the description should explain the treatment process for pathogen reduction and be supported by analytical results for pathogens and indicator organisms and log books documenting operational parameters for sludge treatment units. If the sludge is only Class B, the land applier must keep records describing site restrictions to prevent public exposure to pathogens. The following paragraphs briefly explain each pathogen reduction alternative and the types of records used to demonstrate compliance. The Class A alternatives are designated A1 through A6 and the Class B alternatives are designated B1 through B3. Table 6 summarizes the recordkeeping requirement for each Class A alternative, and Table 7 covers each Class B alternative.

Alternative A1—Time and Temperature

Alternative A1 requires that sludge treatment units be operated to maintain the sludge at a specific temperature for a specific amount of time. Both of these parameters are determined using one of the formulas provided in the regulations. The appropriate equation used to determine the time-temperature relationship is based on the percent total solids of the sewage sludge and on the mechanisms used by the treatment process to heat the sludge.

Table 6
Recordkeeping Requirements for Class A Pathogen Reduction Alternatives

Alternative A1—Time and Temperature

- Analytical results for density of Salmonella sp. bacteria or fecal coliform (most probable number)
- Sludge temperature (either continuous chart or two readings per day, at least one per shift)
- Time (days, hours, minutes) temperature maintained

Alternative A2—Alkaline Treatment

- Analytical results for density of Salmonella sp. bacteria or fecal coliform (most probable number)
- Sludge Ph (beginning, middle, and end of treatment)
- Time (hours) pH maintained above 12 (at least 72 hours)
- Sludge temperature (beginning, middle, and end of treatment and hourly to demonstrate 12 hours above 52°C)
- Percent solids in sludge after drying (at least 50 percent)

Alternative A3—Analysis and Operation

- Analytical results for density of Salmonella sp. bacteria or fecal coliform (most probable number)
- Analytical results for density of enteric viruses (plaque forming unit/4 grams total solids) prior to pathogen reduction and, when appropriate, after treatment
- Analytical results for density of viable helminth ova (number/4 grams total solids) prior to pathogen reduction and, when appropriate, after treatment
- Values or ranges of values for operating parameters to indicate consistent pathogen reduction treatment

Alternative A4—Analysis Only

- Analytical results for density of Salmonella sp. bacteria or fecal coliform (most probable number)
- Analytical results for density of enteric viruses (plaque forming unit/4 grams total solids)
- Analytical results for density of viable helminth ova (number /4 grams total solids)

Alternative A5—Processes to Further Reduce Pathogens (PFRP)

- Heat Drying
  - Analytical results for density of Salmonella sp. bacteria or fecal coliform (most probable number)
  - Moisture content of dried sludge < 10 percent
  - Logs documenting temperature of sludge particles or wet bulb temperature of exit gas exceeding 80°C (either continuous chart or two readings per day, at least one per shift)
- Thermophilic Aerobic Digestion
  - Analytical results for density of Salmonella sp. bacteria or fecal coliform (most probable number)
  - Dissolved oxygen concentration in digester ≤ 1 mg/L
  - Logs documenting temperature maintained at 55-60°C for 10 days (either continuous chart or two readings per day, at least one per shift)
- Heat Treatment
  - Analytical results for density of Salmonella sp. bacteria or fecal coliform (most probable number)
  - Logs documenting sludge heated to temperatures greater than 180°C for 30 minutes (either continuous chart or three readings at 15 minute intervals)
- Pasteurization
  - Analytical results for density of Salmonella sp. bacteria or fecal coliform (most probable number)
  - Temperature maintained at or above 70°C for at least 30 minutes (either continuous chart or two readings per day, at least one per shift)
- Composting
  - Analytical results for density of Salmonella sp. bacteria or fecal coliform (most probable number)
  - Description of composting method
  - Logs documenting temperature maintained at or above 55°C for 3 days if within vessel or static aerated pile composting method (either continuous chart or two readings per day, at least one per shift)
  - Logs documenting temperature maintained at or above 55°C for 15 days if windrow compost method (minimum of two readings per day, at least one per shift)
  - Logs documenting compost pile turned at least five times per day, if windrow compost method
- Gamma Ray Irradiation
  - Analytical results for density of Salmonella sp. bacteria or fecal coliform (most probable number)
  - Gamma ray isotope used
  - Gamma ray dosage at least 1.0 megarad
  - Ambient room temperature log (either continuous chart or two readings per day, at least one per shift)
- Beta Ray Irradiation
  - Analytical results for density of Salmonella sp. bacteria or fecal coliform (most probable number)
  - Beta ray dosage at least 1.0 megarad
  - Ambient room temperature log (either continuous chart or two readings, at least one per shift)

Alternative A6—PFRP Equivalent

- Operating parameters or pathogen levels as necessary to demonstrate equivalency to the PFRP
- Analytical results for density of Salmonella sp. bacteria or fecal coliform (most probable number)

Table 7
Recordkeeping Requirements for Class B
Pathogen Reduction Alternatives

Alternative B1—Fecal Coliform Count
• Number of samples collected during each monitoring event • Analytical results for density of fecal coliform for each sample collected
Alternative B2—Processes to Significantly Reduce Pathogens (PSRP)
• Aerobic Digestion - Dissolved oxygen concentration - Volatile solids content before and after digestion - Mean residence time of sludge in digester - Logs showing temperature was maintained for sufficient period of time (ranging from 60 days at 15°C to 40 days at 20°C) (continuous charts or two readings per day, at least one per shift) • Air Drying - Description of drying bed design - Depth of sludge on drying bed - Drying time in days - Daily average ambient temperature • Anaerobic Digestion - Volatile solids content before and after digestion - Mean residence time of sludge in digester (between 15 days at 35°C to 55°C and 60 days at 20°C) - Temperature logs of sludge in digester (continuous charts or two readings per day, at least one per shift) • Composting - Description of composting method - Daily temperature logs documenting sludge maintained at 40°C for 5 days (either continuous chart or two readings per day, at least one per shift) - Hourly readings showing temperature exceeded 55°C for 4 consecutive hours • Lime Stabilization - pH of sludge immediately and then 2 hours after addition of lime
Alternative B3—PSRP Equivalent
• Operating parameters or pathogen levels as necessary to demonstrate equivalency to PSRP

The time and temperature requirement for sewage sludge with a solids content of 7 percent or higher is determined using equation 1:

$$D = \frac{131{,}700{,}000}{10^{0.1400t}} \qquad \text{(eq. 1)}$$

where:

D = Time in days

t = Temperature in degrees Celsius.

This equation was developed for sewage sludges that are at least 7 percent total solid and are treated by pasteurization or composting. To use this equation to determine pathogen reduction reliably, the sludge temperature must be maintained at 50° C or higher and the detention time must be at least 20 minutes.

The minimum time endpoint is not appropriate for treatment processes that heat the small particles of sewage sludge with warm gases or an immiscible liquid. If sewage sludge particles are heated by either warm gases or an immiscible liquid and the percent total solids is 7 percent or higher, the specific temperature and time relationship is still determined using equation (1). However, the minimum value for time that can be used in the equation is now 15 seconds. The shorter time is allowed because heat transfer is more efficient for such processes as rotary driers that use this technique for heating sludge particles. The minimum value for the temperature variable is still 50° C.

When the percent total solids is less than 7 percent and the detention time is greater than 15 seconds but less than 30 minutes, then equation (1) is still used to determine the specific time and temperature values that achieve compliance with the requirement.

When the percent total solids is less then 7 percent and the time is more than 30 minutes and the temperature of the sewage sludge is 50° C or higher, then a less stringent equation (eq. 2) may be used to determine the specific time and temperature values.

$$D = \frac{50{,}070{,}000}{10^{0.1400t}} \qquad \text{(eq. 2)}$$

where:

D = Time in days

t = Temperature in degrees Celsius.

To demonstrate compliance with the operational parameters, the responsible individual should check the temperature in the sludge treatment unit(s) and record it to demonstrate that the sludge was held at a constant temperature for the required number of days. If the temperature is not recorded continuously, it should be checked and recorded during each work shift or at least twice a day.

The objective is to obtain temperature readings that are representative of the temperature maintained throughout the treatment process. So, for example, if the treatment unit is operated 24 hours a day, each

temperature reading should be evenly spaced, if feasible. Otherwise, temperature readings should be taken at the beginning and end of the work day. If the process is operated for 1 day or less, record the sludge temperature at the beginning, middle, and end of treatment.

In addition, records must document the detention time of the sludge in the treatment unit. Records should also identify the daily input of sludge to the treatment unit(s) and the withdrawal of supernatant and processed sludge. The size (gallons) of the treatment unit(s) should also be documented.

In addition to documenting the treatment unit operating parameters, Alternative A1 requires documentation of monitoring for either Salmonella sp. bacteria or fecal coliform at the time of use or disposal. The preparer should keep the following records documenting sampling and analysis for either Salmonella sp. bacteria or fecal coliform and percent solids:

- Date and time of sample collection, sampling location, sample type, sample volume, name of sampler, type of sample container, and methods of preservation, including cooling
- Date and time of sample analysis, name of analyst, and analytical methods used
- Laboratory bench sheets indicating all raw data used in the analyses and the calculation of results (unless a contract laboratory performed the analyses for the preparer)
- Name of contract laboratory, if applicable
- Sampling and analytical QA/QC procedures
- Analytical results expressed as dry weight.

Alternative A2—Alkaline Treatment

Alternative A2, like Alternative A1, requires the analysis of sludge quality and the evaluation of operating parameters. As with the time and temperature alternative, the sludge must be monitored for either Salmonella sp. bacteria or fecal coliform. The sludge must be kept at a pH of 12 for 72 hours. The temperature must be greater than 52°C for at least 12 of these hours. At the end of the 72-hour period, the sludge must be air-dried until it is more than 50-percent solid. When properly performed, this pathogen reduction alternative also achieves vector attraction reduction (see Section 3.3).

Use of this alternative requires that operating logs be kept that document pH, temperature, residence time, and percent total solids. The temperature of the sewage sludge should be checked and recorded to

document it is above 52°C for 12 continuous hours during the required 72-hour holding period. If the temperature is not continuously monitored, it should be checked hourly when feasible. At a minimum, it should be recorded at the beginning, middle, and end of treatment. Similarly, the pH of the sewage sludge should be recorded at the beginning, middle, and end of the required 72-hour holding period. The percent total solids also should be determined for each batch. Analytical records (described under the time and temperature alternative) for pathogenic organisms must document that sludge was analyzed at the time of use or disposal for either Salmonella sp. bacteria or fecal coliform at the frequency specified in Table 4.

Alternative A3—Analysis and Operation

Alternative A3, like the first two alternatives, utilizes a combination of sludge quality analysis and documentation of operating parameters. In addition to monitoring for either fecal coliform or Salmonella sp. bacteria, preparers must monitor for enteric viruses and viable helminth ova. If the preparer follows the steps outlined in Figure 3, he or she can substitute documentation of operating parameters for periodic analysis of enteric viruses and viable helminth ova. The preparer must sample sludge prior to pathogen reduction. If the analytical results show that enteric viruses and viable helminth ova are not detected, then the sludge meets Class A. Otherwise, the preparer must sample and analyze the sludge after pathogen reduction treatment. If this final sludge meets the Class A requirements after treatment, the preparer may document consistent maintenance of operating parameters shown to achieve appropriate pathogen reductions instead of analyzing samples of the sewage sludge for enteric viruses and/or viable helminth ova. Regardless of how the preparer demonstrates compliance with the enteric virus and viable helminth ova requirement, the final sludge must be sampled and analyzed at the time of use or disposal for either fecal coliform or Salmonella sp. bacteria according to the frequency specified in Table 4.

Records must include documentation of sludge sampling and analysis before and after pathogen reduction treatment. Refer to the time and temperature alternative for a list of sampling and analysis records. The records also must define the values used for operating parameters between the before- and after-treatment sludge analyses. If operating parameters are substituted for periodic sludge monitoring, records must also document that these values are maintained consistently. The specific operating parameters that must be recorded to demonstrate compliance may vary depending on the particular pathogen reduction process used (e.g., composting, pasteurization).

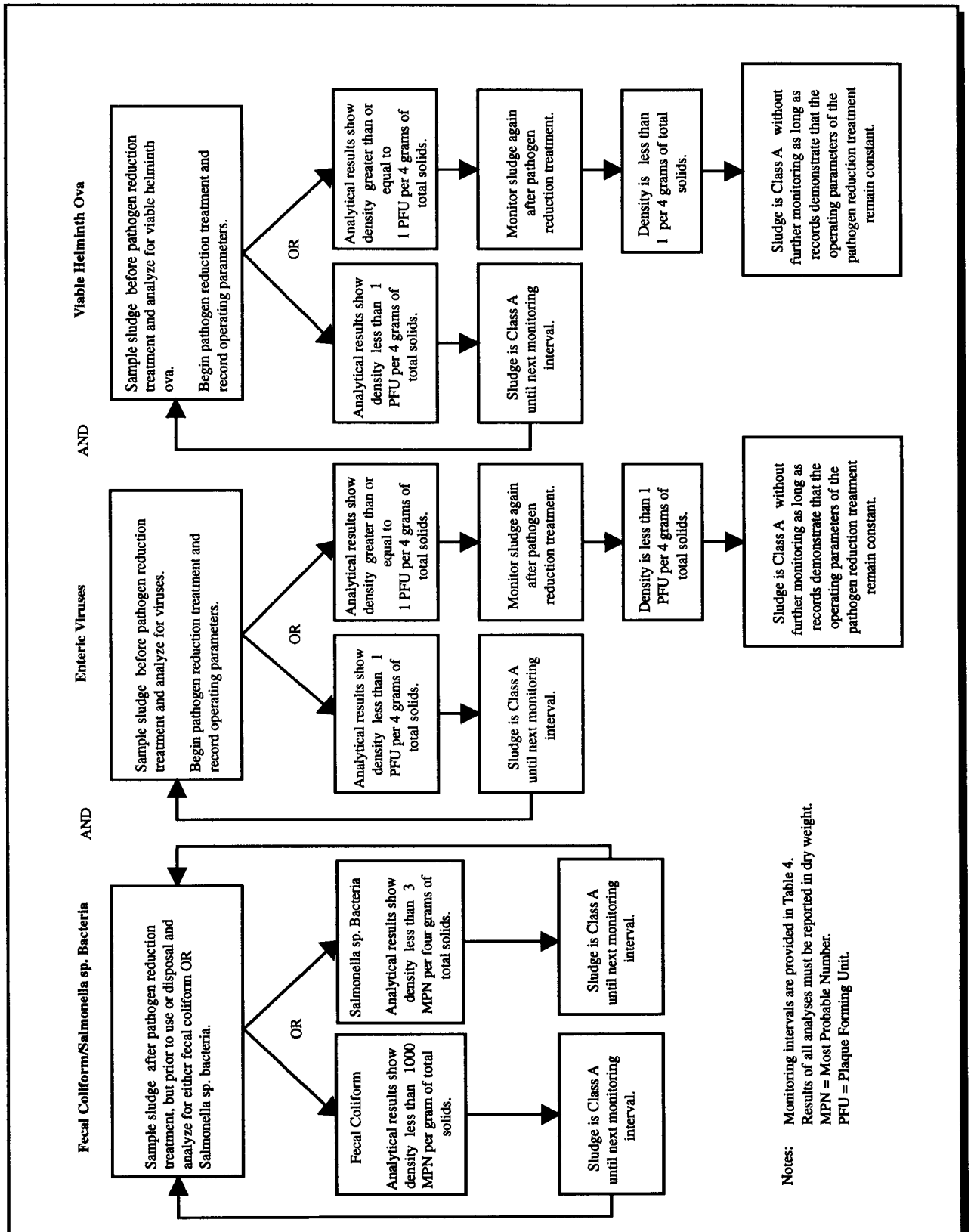

Figure 3: Pathogen Reduction Alternative A3 — Analysis and Operation

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Alternative A4—Analysis Only

Alternative A4 relies solely on the analysis of sewage sludge for pathogens (i.e., Salmonella sp. bacteria, enteric viruses, and viable helminth ova) and indicator organisms (i.e., fecal coliform) to demonstrate pathogen reduction.

Records must document that these parameters were sampled and analyzed at least as often as specified in the Part 503 regulation (see Table 4). The preparer should keep records documenting the following items for each sampling event:

- Date and time of sample collection, sampling location, sample type, sample volume, name of sampler, type of sample container, and methods of preservation, including cooling
- Date and time of sample analysis, name of analyst, and analytical methods used
- Laboratory bench sheets indicating all raw data used in the analyses and the calculation of results (unless a contract laboratory performed the analysis for the preparer)
- Name of contract laboratory, if applicable
- Sampling and analytical QA/QC procedures
- Analytical results expressed as dry weight.

Alternative A5—Processes to Further Reduce Pathogens

Alternative A5 requires a combination of sludge analysis for either fecal coliform or Salmonella sp. bacteria and documentation of operating parameters. The specific operating parameters that must be evaluated are defined by the Processes to Further Reduce Pathogens (PFRPs) that were originally established in 40 CFR Part 257. These have been modified slightly and are included in Appendix B of Part 503. The seven different processes and the specific operating parameters for each are included in Table 6. Records should include a description of the pathogen reduction process, documentation of sampling and analysis of the sludge for fecal coliform or Salmonella sp. bacteria, and log books documenting proper operation of pathogen reduction processes.

Alternative A6—PFRP Equivalent

Alternative A6 requires a combination of sludge analysis and documentation of operating parameters. As with the other Class A alternatives, the sludge must be monitored for either fecal coliform or Salmonella sp. bacteria. Alternative A6 requires sewage sludge to be treated in a process equivalent to

a PFRP, as determined by the permitting authority. The permitting authority should have specified the appropriate records to demonstrate compliance with this alternative. The records could include temperature in sludge treatment units, retention time, pH, solids or moisture content, and dissolved oxygen (DO) concentration.

Alternative B1—Fecal Coliform Count

Alternative B1 requires the analysis of the sewage sludge for fecal coliform. The responsible individual should maintain the following records demonstrating compliance with the fecal coliform level:

- Date and time of sample collection, sampling location, sample type, sample volume, name of sampler, type of sample container, and methods of preservation, including cooling
- Date and time of sample analysis, name of analyst, and analytical methods used
- Laboratory bench sheets indicating all raw data used in the analyses and the calculation of results (unless analysis was performed by a contract laboratory)
- Name of contract laboratory, if appropriate
- Sampling and analytical QA/QC procedures
- Analytical results expressed as dry weight
- Calculation of the geometric mean of the seven samples analyzed to demonstrate compliance with the maximum allowable level (see Table 3).

In addition, the use of this alternative and any other Class B pathogen reduction alternative for bulk sewage sludge that will be land applied requires that the land applier demonstrate compliance with specific site restrictions. The preparer is responsible for keeping records on the site restrictions only when he or she is also performing the land application.

Alternative B2—Processes to Significantly Reduce Pathogens

The Processes to Significantly Reduce Pathogens (PSRPs) were originally established in 40 CFR Part 257. These have been modified slightly and are included in Appendix B of Part 503. As with the PFRP alternative, the specific operating parameters that must be evaluated vary depending on the sludge treatment process used, as listed in Table 7. Records should include a description of the pathogen reduction process and log books documenting regular and frequent evaluations of the operating parameters.

Alternative B3—PSRP Equivalent

Alternative B3 requires sewage sludge to be treated in a process equivalent to a PSRP, as determined by the permitting authority. The permitting authority should have specified the appropriate records to demonstrate compliance with this alternative. The records could include temperature in sludge treatment units, retention time, pH, solids or moisture content, and DO concentration.

3.3 Records of Vector Attraction Reduction

When sewage sludge is land applied or placed in an active surface disposal unit, the Part 503 regulation requires a certification that the vector attraction reduction requirements were met and a description of how these requirements were achieved. The description should be supported by documentation of process controls and management practices for treatment processes that achieve vector attraction reduction. As with the pollutant and pathogen records, this documentation must be kept for 5 years.

There are a total of 11 options to comply with the vector attraction reduction requirements. The first eight options (see Table 8) apply to both the land application and surface disposal sludge quality requirements. These eight options, referred to as the sludge processing options, involve sludge treatment to reduce vector attraction characteristics. They are performed primarily by preparers during or immediately after pathogen reduction. Options 9 through 11, referred to as the sludge management options, are performed by land appliers at the land application site or by owners/operators of surface disposal sites after placement on the sewage sludge unit. These sludge management options are not included in this guidance because they are not performed by the preparer, unless the preparer is also the land applier or owner/operator of the surface disposal site. However, they are discussed in the following documents:

- *Land Application of Sewage Sludge—A Guide for Land Appliers on the Recordkeeping and Reporting Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge, 40 CFR Part 503* (EPA, 1993)

- *Surface Disposal of Sewage Sludge—A Guide for Owners/Operators of Surface Disposal Facilities on the Monitoring, Recordkeeping, and Reporting Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge, 40 CFR Part 503* (EPA, 1993).

Table 8
Recordkeeping Requirements for Vector Attraction Reduction Sludge Processing Options

Option 1—Volatile Solids (VS) Reduction	**Option 5—Aerobic Processing(Thermophilic Aerobic Digestion/Composting)**
• Volatile solids concentration of raw and final sludge streams (mg/kg) • Calculations showing 38 percent reduction in volatile solids	• Sludge detention time in digester/composting • Temperature logs (at least two readings per day) showing average temperature above 45°C and minimum temperature above 40°C for 14 consecutive days
Options 2 and 3—Bench-Scale VS Reduction	**Options 6—Alkaline Treatment**
• One-time description of bench-scale digester • Time (days) that sample was further digested in bench-scale digester (30 days for aerobically and 40 days for anaerobically digested sludge) • Temperature logs (at least two readings per day) showing temperature maintained at 20°C for aerobically or between 30°C and 37°C for anaerobically digested sludge • Volatile solids concentration of sludge (mg/kg) before and after bench-scale digestion	• Logs demonstrating hours pH of sludge/alkaline mixture was maintained (12 for 2 hours and 11.5 for an additional 22 hours) • Amount of alkaline added to sludge (lbs or gals) • Amount of sludge treated
Option 4—Specific Oxygen Update Rate	**Options 7 and 8—Drying**
• Dissolved oxygen readings for sludge sample over 15-minute intervals (mg/L) • Temperature logs at beginning and end of DO readings showing test was conducted at 20°C • Total solids for sludge sample (g/L) • SOUR calculations (mg/g)	• Results of percent solids (dry weight) test • Presence of unstabilized solids generated during primary treatment

Options 1 Through 3—Volatile Solids Reduction

Volatile solids are representative of the unstable, putrescable organic matter in the sludge. Reductions in organic matter reduce putrescibility and, thus, vector attraction. Option 1 requires a demonstration that volatile solid concentrations are reduced by 38 percent between the raw sludge and the digested sludge. *Control of Pathogens and Vectors in Sewage Sludge* (EPA, 1992) presents several methods of calculating volatile solids reduction. The simplest equation is reproduced below:

$$\%VS_{Reduction} = \frac{\%VS_{(raw)} - \%VS_{(stabilized)}}{\%VS_{(raw)} - [\%VS_{(raw)} \times \%VS_{(stabilized)}]}$$

where:

$VS_{Reduction}$ = Percent reduction of volatile solids

$VS_{(raw)}$ = Volatile fraction in raw sewage sludge

$VS_{(stabilized)}$ = Volatile fraction in stabilized sewage sludge.

The preparer needs to maintain records on the volatile solids content (mg/kg) of both of these streams and the calculation of volatile solids reduction. While most preparers evaluate this parameter regularly to document constant process operation, records must show that volatile solids reduction was evaluated at least as frequently as specified in Table 4 in Section 2.

Options 2 and 3 are methods to demonstrate that vector attraction reduction is achieved even though 38 percent volatile solids reduction was not attained. Option 2 applies to anaerobically digested sludge, and Option 3 applies to aerobically digested sludge. These methods involve taking a sample of the final digested sludge and digesting it further in a bench-scale apparatus for a specified period over a specific temperature range. It is important to dilute the sample of aerobically digested sludge to 2 percent solids or less. Bench-scale tests run with a higher percent solids do not produce reliable results. Percent solids does not affect tests performed on anaerobicly digested sludge. If the sludge sample is from an anaerobic digester, the bench-scale unit must be operated between 30°C and 37°C for 40 days. Vector attraction reduction is achieved if the volatile solids are reduced by less than 17 percent in the bench-scale digester. If the sample is taken from an aerobic digester, the bench-scale unit must be operated at a temperature of 20°C for 30 days. Vector attraction reduction is achieved if the volatile solids are reduced by less than 15 percent in the bench-scale digester. The following records demonstrate that these alternatives are met:

- A description of the bench-scale digester and its operation
- The time (days) that the previously digested sludge sample was further digested in the bench-scale digester
- The temperature (degrees Celsius) maintained in the bench-scale digester for the time (days) the sample was being further digested; the temperature should either be recorded continuously or it should be checked and recorded during each work shift or during at least two well-spaced intervals during each day.

Option 4—Specific Oxygen Uptake Rate

The specific oxygen uptake rate (SOUR) is the rate by which oxygen is consumed by microorganisms in the sludge. A reduction of this rate indicates a lack of organic matter to be further oxidized or broken down and, therefore, reduced vector attractiveness. Vector attraction reduction is achieved if the SOUR is equal to or less than 1.5 mg of oxygen per hour per gram of total solids at a temperature of 20°C. The preparer should perform the SOUR test and record the following information to demonstrate compliance:

- DO readings of the sludge taken at 1-minute intervals over a 15-minute period or until the DO is reduced to less than 1 mg/L and the average DO value used in the SOUR calculation
- Calibration records for the DO meter
- Total solids determination for the sludge in g/L
- Temperature (degrees Celsius) taken at the beginning and end of the procedure
- Calculation of SOUR using the following equation:

$$SOUR = \frac{oxygen\ consumption\ rate\ per\ minute\ \left(\frac{DO\ mg/L}{min}\right)}{total\ solids\ (g/L).}\ (60\ min/hour)$$

While most preparers evaluate this parameter regularly to document constant process operation, the records must demonstrate that the SOUR was evaluated at least as frequently as specified in Table 4 in Section 2.

Option 5—Aerobic Processing

Aerobic processing, such as thermophilic aerobic digestion and composting, is effective for reducing vector attraction characteristics because the higher operating temperatures achieve higher rates of organic solids reduction. To achieve vector attraction reduction under Option 5, the aerobic process must be operated for 14 days with a minimum temperature greater than 40°C and an average temperature between 45°C and 60°C. The preparer should record the following information to demonstrate compliance:

- Sludge residence time
- Temperature (degrees Celsius) of the sewage sludge; the temperature should either be recorded continuously or checked and recorded at least once per work shift or at least twice a day.

Sludge residence time is determined by dividing the digester volume (one-time measurement [gallons]) by the volumetric flow rate through the digester (measured on a continuous basis [gpd]).

Option 6—Alkaline Treatment

The alkaline treatment process destroys or inhibits pathogens and the microorganisms that decompose sludge. Therefore, odors and putrescibility are reduced, leading to reduced vector attraction. For Option 6, the pH of the sewage sludge must be raised to 12 and maintained there for 2 hours without adding extra alkaline. Then the pH must remain at or above 11.5 for an additional 22 hours. The preparer should maintain the following records to document alkaline treatment:

- pH (standard units) recorded at least at the 0, 2, and 24-hour intervals of treatment
- Duration of time (hours) that pH is maintained at or above specified minimum levels
- Amount (pounds or gallons) of alkaline material added
- Amount of sludge treated (e.g., gallons, kilograms).

Options 7 and 8—Drying

Heat and air drying remove moisture from the sludge, thereby reducing pathogenic organisms and odor. Odor reduction leads to reduced vector attractiveness. Two vector attraction reduction alternatives involve drying. The primary distinction between the two is whether or not unstabilized solids generated during primary wastewater treatment are a component of the sewage sludge. If unstabilized primary wastewater solids (i.e., raw sludge) are present, then the percent total solids of the final sewage sludge must be at least 90 percent to meet the vector attraction reduction requirement. If raw sludge is not present, then the percent total solids of the final sewage sludge must be 75 percent (or greater). The preparer should determine percent total solids for each batch of sludge and keep the following records to demonstrate compliance:

- Results of solids analysis of sewage sludge prior to mixing with other material(as dry weight) expressed as percent of final sludge
- Presence of unstabilized solids generated during primary treatment.

Records must demonstrate that the analysis of percent total solids was performed at least as frequently as specified in Table 4 in Section 2.

> ***Unstabilized solids*** — Unstabilized solids are organic materials in sewage sludge that have not been treated in either an anaerobic or aerobic treatment process.

4. NOTIFICATION AND REPORTING

Several notification and reporting requirements are directed at persons who prepare sewage sludge. These include notice and necessary information, notice of interstate transport, and annual reports. The first two, notice and necessary information and notice of interstate transport, are applicable when the sewage sludge is going to be land applied. However, if the sewage sludge that is prepared for land application meets the exceptional quality criteria, then the notification requirements do not apply. This section describes all three notification and reporting requirements.

4.1 Notice and Necessary Information

When sewage sludge is prepared for land application in bulk form or for distribution in a bag or other container, the preparer must inform the applier of the sludge quality. The notification requirements are different if the sludge is sold or given away in a bag or other container rather than being land applied in bulk. The notice and necessary information requirement does not apply when the sewage sludge or the material derived from sewage sludge meets the exceptional quality criteria. A sample format for providing notice and necessary information is in Appendix B.

Bulk Sewage Sludge

When bulk sewage sludge that is not exceptional quality is prepared for land application, both the preparer and the land applier have notification requirements. The preparer must provide the following sludge quality information to the land applier:

- Pollutant concentrations
- Nitrogen concentration (TKN, ammonia, and nitrate nitrogen)
- Pathogen reduction level achieved (Class A or Class B)
- Vector attraction reduction option used (Options 1-8).

The land applier must have this information to comply with the Part 503 regulation when land applying the sewage sludge. If the pollutants do not meet the pollutant concentration limits in Table 3 of 40 Code of Federal Regulation (CFR) 503.13, then the land applier must track the cumulative pollutant loading rates. If a Class B pathogen reduction alternative was used, then the land applier must ensure that the site restrictions are met. If the preparer did not perform one of the sludge processing vector attraction reduction options (Options 1-8), then the land applier must perform one of the sludge management vector

attraction reduction options (Options 9-10). For a more detailed description of the responsibilities of the land applier, refer to *Land Application of Sewage Sludge: A Guide for Land Appliers on the Recordkeeping and Reporting Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge* (EPA, 1993).

The land applier is also responsible for providing the land owner or lease holder of the land notice and necessary information to comply with the Part 503 requirements. For example, if the sludge only met Class B pathogen reduction, then the land owner or lease holder must be informed of the site use and access restrictions. In addition, if the pollutant concentration limits in Table 3 of 40 CFR 503.13 are not met, the land applier must track the cumulative pollutant loading rates for each land application site. In this case, the land applier must document and provide the land owner or lease holder with the following information:

- Location of land application site
- Date bulk sludge was applied
- Time bulk sludge was applied, if Vector Attraction Reduction Option 9 or 10 was used
- Number of hectares where the sludge was applied
- Amount of bulk sludge applied
- Cumulative amount of each pollutant (i.e., kilograms) applied.

The land owner or tenant may request specific information, such as analytical results on sludge quality or documentation on how the management practices are met. In general, the example form in Appendix B may be used to satisfy the notice and necessary information requirements of both the preparer and the land applier.

Sewage Sludge Sold or Given Away in a Bag or Other Container

When sludge that does not meet the pollutant concentration limits in Table 3 of 40 CFR 503.13 is sold or given away in a bag or other container, it must be accompanied by a label or instruction sheet. The label or instruction sheet must contain the following information:

- Name and address of the person who prepared the sewage sludge for distribution
- Statement that land application is prohibited except in accordance with the instructions

- Instructions on the annual whole sludge application rate that will comply with the annual pollutant loading rates in Table 4 of 40 CFR 503.13.

4.2 Notice of Interstate Transport

When bulk sewage sludge that does not meet the exceptional quality criteria is going to be applied to land outside the State in which the sludge was prepared, the preparer is required to provide written notice prior to the initial application of the sewage sludge. The written notice must include the following information:

- Location, by either street address or latitude and longitude, of each land application site
- Approximate time when bulk sewage sludge will be applied to the site
- Name, address, telephone number, and National Pollutant Discharge Elimination System permit number for the person who prepares the bulk sewage sludge.

This notice must be submitted to the permitting authority for the State in which the bulk sewage sludge is proposed to be applied. Contact the appropriate EPA Regional office for specific information on where to send this notification.

4.3 Annual Reports

Most preparers are required to report annually to the permitting authority under 40 CFR Part 503. Annual reports cover information and data collected during the calendar year (January 1 to December 31).[1] Reports on sludge quality must include the results from monitoring pollutant concentrations and pathogen levels, a description of operating parameters for pathogen reduction and vector attraction reduction, and certifications that pathogen and vector attraction reductions were achieved. Permits issued by EPA or the State may contain additional reporting requirements.

Who Is Responsible For Submitting Reports Under 40 CFR Part 503?

Facilities responsible for reporting annually are described in the regulation as:

[1] The first annual report required under the regulation is due February 19, 1994. It must contain information generated after the July 20, 1993, compliance deadline through December 31, 1993.

- Publicly owned treatment works (POTW) with an average design influent flow rate equal to or greater than 1 million gallons per day
- POTWs serving a population of 10,000 or more
- Class I sludge management facilities.

Class I facilities are defined as POTWs identified under 40 CFR 403.8(a) as being required to have approved pretreatment programs (even if they are in a State that has elected to assume local pretreatment program responsibility). In addition, the EPA Regional Administrator and State Director may designate any other treatment works as a Class I facility, including sludge generators, processors, land appliers, and owners/operators of surface disposal sites and incinerators. All facilities defined or designated as Class I facilities are subject to the reporting requirements described in this section.

What Information is Required

The Part 503 regulation specifies that reports cover the information that preparers are required to keep in their records. This includes background information on the generation, use, and disposal of sludge; the results of sludge quality analysis; and a description and certification for pathogen and vector attraction reduction requirements. This section describes the specific data and documentation that must be submitted.

Preparers are asked to report basic information about the sludge amount and its use or disposal. Specific facts needed by EPA and the State include the following:

- Amount of sludge generated, in metric tons expressed as a dry weight (see Appendix C for equations to convert sludge volume to metric tons)
- Use or disposal practices
- Amount of sludge that goes to each use or disposal practice
- Name and address of the preparer who will receive the sludge next, if applicable
- Name and address of the land applier and owner/operator of the surface disposal site , if different from the generator.

The reporting requirements for pollutant limits include submission of the analytical results from monitoring pollutant concentrations in the sewage sludge. Reports should include the results of all

analyses performed during the reporting period using the prescribed analytical method(s). Analytical results must be reported as milligrams per kilogram dry weight. Reports should also indicate which analytical methods were used, how frequently sludge was monitored, and the types of samples collected. Preparers may have to report additional information regarding pollutants if they beneficially use or dispose of the sludge themselves.

Preparers also are required to submit a certification and description of how the pathogen reduction requirements were met. A detailed description of the pathogen reduction treatment process should include the type of process used and standard operating procedures. It should identify specific values for all operating parameters. The description should also include a schematic diagram. The certification statements required by the 503 Rule are listed in Section 503.17, Recordkeeping, and have been reproduced in Appendix D of this document. It should be noted that the preparer of sludge meeting only Class B pathogen reduction requirements does not have to report records kept by the land applier, land owner, or lease holder on the site restrictions used to limit public contact with the sludge once it is applied. In addition, if sludge is placed on an active surface disposal unit and covered daily, the preparer does not have to perform or report on pathogen reduction.

Finally, preparers are required to report information regarding vector attraction reduction when one of the sludge processing options is used (Options 1-8). The report must contain a description and certification that the vector attraction reduction requirements were met.

When and Where Are Reports Submitted?

Annual reports required under Part 503 are due February 19 every year beginning in 1994. Annual reports must be submitted to the Permitting Authority, which is the EPA Regional Water Compliance Branch Chief until State sludge management programs are delegated the responsibilities of the Federal program. The address for each Branch Chief is provided on the inside back cover of this booklet. The map on the front cover shows the EPA Region in which each State is located.

REFERENCES

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U.S. Environmental Protection Agency. 1989. *POTW Sludge Sampling and Analysis Guidance Document*. Washington, DC: Office of Water.

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U.S. Environmental Protection Agency. 1986. *Test Methods for Evaluating Solid Wastes (SW-846)*. Washington, DC: Office of Solid Waste.

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ADDITIONAL REFERENCES FROM EPA

Draft Materials Available During Fall/Winter 1993 — *Guide to 503 Risk Assessment, Odor Control Handbook, Plain English Guide to 503, Update to Beneficial Use Policy.*

Additional fact sheets and guidance documents that address specific topics related to the use or disposal of sewage sludge are also under development.

APPENDIX A

WORKSHEET FOR CALCULATING THE ANNUAL WHOLE SLUDGE APPLICATION RATE TO MEET THE ANNUAL POLLUTANT LOADING RATE

CALCULATION WORKSHEET FOR DETERMINING ANNUAL WHOLE SLUDGE APPLICATION RATE (AWSAR)

Applicability:

For sewage sludge sold or given away in a bag or other container where the pollutant concentrations exceed those in Table 3 of §503.13 but do not exceed those in Table 1 of §503.13.

Procedure:

Step 1: Measure the concentration of the pollutants listed in column 1 for the sewage sludge. Record the concentration in column 3 according to milligrams of pollutant per kilogram of solids in the sludge.

Step 2: Perform the calculation as shown for each pollutant and record the annual whole sludge application rate in column 4.

COLUMN 1 POLLUTANT	COLUMN 2 ANNUAL POLLUTANT LOADING RATE, kg/ha/365 days		COLUMN 3 POLLUTANT CONCENTRATION, mg/kg			COLUMN 4 ANNUAL WHOLE SLUDGE APPLICATION RATE, tonnes/ha/365 days
ARSENIC	2.0	÷	_____	X 1000	=	_____
CADMIUM	1.9	÷	_____	X 1000	=	_____
CHROMIUM	150	÷	_____	X 1000	=	_____
COPPER	75	÷	_____	X 1000	=	_____
LEAD	15	÷	_____	X 1000	=	_____
MERCURY	0.85	÷	_____	X 1000	=	_____
MOLYBDENUM	0.90	÷	_____	X 1000	=	_____
NICKEL	21	÷	_____	X 1000	=	_____
SELENIUM	5.0	÷	_____	X 1000	=	_____
ZINC	140	÷	_____	X 1000	=	_____

Step 3: Compare each of the annual whole sludge application rates in column 4 and choose the lowest recorded rate. Record the number in the space provided below.

THE ALLOWABLE AWSAR* IS: _____ **metric tons per hectare per 365 days.**

* Please note that any time the sludge quality changes, the annual whole sludge application rate must be reevaluated. To reduce the frequency that the label must be changed, the preparer may opt to base the AWSAR on the highest concentration recorded for each pollutant from historical data. However, the preparer must continue to compare sludge concentrations data to the pollutant concentrations used to develop the AWSAR.

APPENDIX B

SAMPLE FORMAT PROVIDING NOTICE AND NECESSARY INFORMATION

NOTICE AND NECESSARY INFORMATION

This form is to assist compliance with the bulk sewage sludge notification requirements [503.12(f)]. Please note, however, that if the sewage sludge meets the exceptional quality criteria, then the notification requirements do not apply. This form can be used by preparers of sewage sludge to transmit information to land appliers and also by land appliers to transmit information to land owners or lease holders.

Part I — To Be Completed by PREPARERS of Sewage Sludge

A. Please provide pollutant concentrations

Name	Concentration (mg/kg) Dry Weight	Pollutant Concentrations (Table 3, 40 CFR 503.13) (monthly average)	Ceiling Concentrations* Table 1, 40 CFR 503.13) (daily maximum)
Arsenic		41 mg/kg	75 mg/kg
Cadmium		39 mg/kg	85 mg/kg
Chromium		1200 mg/kg	3000 mg/kg
Copper		1500 mg/kg	4300 mg/kg
Lead		300 mg/kg	840 mg/kg
Mercury		17 mg/kg	57 mg/kg
Molybdenum		18 mg/kg	75 mg/kg
Nickel		420 mg/kg	420 mg/kg
Selenium		36 mg/kg	100 mg/kg
Zinc		2800 mg/kg	7500 mg/kg
Nitrogen Concentration		N/A	N/A

*Sludge may not be land applied if any pollutant exceeds these values.

B. Pathogen Reduction (40 CFR 503.32) — Please indicate the level achieved

☐ Class A ☐ Class B

C. Vector Attraction Reduction (40 CFR 503.33) — Please indicate the option performed

☐ Option 1 ☐ Option 2 ☐ Option 3 ☐ Option 4

☐ Option 5 ☐ Option 6 ☐ Option 7 ☐ Option 8

☐ No vector attraction reduction options were performed

D. CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

A. Name and Official Title *(type or print)*	B. Area Code and Telephone Number
C. Signature	D. Date Signed

Part II — To Be Completed by LAND APPLIERS of Sewage Sludge

A. If the **pollutant levels** in the sewage sludge do not meet the **pollutant concentration** limits in Table 3, then the land applier must provide the land owner with the following information:

1. Location of land application site _____

2. Number of hectares where the sludge was applied _____

3. Date and time bulk sewage sludge was applied _____

4. Amount of bulk sludge applied _____

5. Record the amount of each metal and nitrogen applied in pounds per acre or kilogram per hectare.

Units	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Molybdenum	Nickel	Selenium	Zinc	Nitrogen

B. If a Class B pathogen reduction alternative was used (see Part I), then the following site restrictions must be met. Please check the boxes if any of the site restrictions apply.

1. Food crops that may touch the sewage sludge/soil mixture cannot be harvested before the end of the following waiting period:

   ☐ a. If harvested parts are totally above the land, wait to harvest for 14 months after the application of sludge.

   ☐ b. If harvested parts are below the land surface and the sludge sat on top of the soil for 4 months before the field was plowed, wait to harvest for 20 months after the initial application of sludge.

   ☐ c. If harvested parts are below the land surface and the sludge was incorporated into the soil within 4 months of being applied, wait to harvest for 38 months after the initial application.

2. ☐ Feed crops cannot be harvested for 30 days after application of the sludge.

3. ☐ Animals cannot graze on the land for 30 days after application of the sludge.

4. ☐ If harvested turf is used for a lawn or other purpose where there is a high potential for public exposure, then the turf cannot be harvested for 1 year after the application of the sludge to the land.

5. ☐ Public access to land with a high potential (parks, playgrounds, golf courses) for public exposure will be restricted for 1 year after the application of the sludge.

6. ☐ Public access to land with a low potential (private property, remote or restricted public lands) for public exposure will be restricted for 30 days after the application of the sludge.

C. If the preparer did not perform vector attraction reduction options (see Part I), then either option 9 or 10 must be performed by the land applier. Please indicate if option 9 or 10 was performed. Check appropriate box.

☐ Option 9—Subsurface Injection ☐ Option 10—Incorporated (plowed) into the Soil ☐ N/A

D. CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

A. Name and Official Title *(type or print)*	B. Area Code and Telephone Number
C. Signature	D. Date Signed

APPENDIX C

EQUATIONS FOR CONVERTING SLUDGE VOLUME TO METRIC TONS

EQUATIONS FOR CONVERTING SLUDGE VOLUME TO DRY METRIC TONS

Applicability:

The amount of sewage sludge used or disposed must be reported as metric tons, dry weight.

Procedure:

Step 1: Convert the common measure (e.g., cubic yards or gallons) to the English System or short tons, dry weight.

$$\textit{Dry short tons} = \textit{gallons of sewage sludge} \times \frac{8.34\ lb}{gallon} \times \frac{ton}{2000\ lb} \times \textit{Percent Solids}$$

8.34 lb/gal is the density of water. This equation is therefore applicable to liquid sludges (less than 5 percent solids). Site-specific densities may be determined and substituted in this equation for a more accurate result.

$$\textit{Dry short tons} = \textit{cubic yards (wet) of sewage sludge} \times \frac{Y\ lb}{cubic\ yard} \times \frac{ton}{2000\ lb} \times \textit{Percent Solids}$$

Y lb/cubic yard is the site-specific bulk density of the sewage sludge. It must be determined for each type of sludge prepared and substituted in the equation for accurate results.

Step 2: If you are starting with the English System or short tons, convert them to dry weight.

$$\textit{Dry tons} = \textit{Wet tons} \times \textit{Percent Solids}$$

Step 3: Convert the English System or short tons to metric tons.

$$\textit{Dry metric tons} = \textit{Dry short tons} \times .907$$

APPENDIX D

CERTIFICATION STATEMENT

EXAMPLE CERTIFICATION STATEMENT FOR PATHOGEN REDUCTION AND VECTOR ATTRACTION REDUCTION

"I certify, under penalty of law, that the [***insert either*** Class A pathogen requirements in §503.32(a) *or* Class B pathogen requirements in §503.32(b)] and the vector attraction reduction requirement in *[**insert** one of the vector attraction reduction requirements in §503.33(b)(1) through §503.33(b)(8)]* [***insert either*** have *or* have not] been met. This determination has been made under my direction and supervision in accordance with the system designed to ensure that qualified personnel properly gather and evaluate the information used to determine that the pathogen and vector attraction reduction requirements have been met. I am aware that there are significant penalties for false certification including fine and imprisonment."

Note: The exact language of the certification should be tailored to accurately describe which requirements have been met and which have not been met, when applicable.

GUIDANCE FOR DETERMINING DEWATERED SLUDGE BULK DENSITY

Applicability:

Determine the site-specific bulk density of sewage sludge to accurately determine the amount of sewage sludge used or disposed.

Procedure:

Step 1: Using a container of known volume [i.e., cubic feet (cu. ft.)] and known weight, obtain a sample of dewatered sludge (cake) from truck trailer, storage container, or pile. Since this sample should be representative of the cake as it is hauled away, the container should not be filled by forcing an excessive quantity of cake into it. It is recommended that the sample of cake be dropped into the sample container from a height of 1 - 2 feet until it overflows. The excess cake should then be scraped away so that the top of the sample is even with the top of the container. Alternatively, the container may be held about one foot under the dewatered sludge discharge conveyor or pump if the location can be safely accessed.

Step 2: Obtain the net weight of the cake sample in the container as follows:

$$\frac{\textit{Wet Weight of Sample and Container} - \textit{Weight of Container}}{\textit{Wet Weight of Sample}}$$

Step 3: Calculate the bulk density of the sample of sewage sludge. The bulk density is the weight of the sample per unit volume of the sample container (i.e., X lb/cu. ft).

$$\frac{\textit{Wet Weight of Sample (lb)}}{\textit{Volume of container (cu. ft.)}} = \textit{X lb/cu. ft.}$$

Step 4: Convert the bulk density obtained from Step #3 to pounds (wet weight) per cubic yard. Example:

$$\textit{(X lb/cu. ft.) x (27 cu. ft./cu. yd.)} = \textit{Y lb (wet weight)/cu. yd.}$$

The site-specific bulk density determined is now used in the equation presented in Appendix C of the document entitled *Preparing Sewage Sludge for Land Application or Surface Disposal* to calculate dry short tons and then dry metric tons.

Step 5: More than one sample should be collected and the density determined to improve the accuracy. It is suggested that a minimum of seven samples be collected. Use the average of the results of the samples. Also, this analysis should be conducted periodically to monitor any possible changes in the bulk density.

Step 6: It is recommended that a minimum sample container (or bucket) volume equivalent to at least 2.5 gallons be used to collect the cake sample. The volume of your container should be verified by measuring the liquid volume capacity to the top of the container. Assuming your container capacity is in gallons, convert the volume of the container to cubic feet by the following formula:

$$\textit{Volume of container (cu. ft.)} = \frac{\textit{Volume of container (gallons)}}{7.48}$$

Avoid using a narrow mouth container to collect dewatered sludge samples.